ACTUATOR ARM DESIGN FOR REDUCING POWER CONSUMPTION IN A DISK DRIVE DATA STORAGE DEVICE

BACKGROUND OF THE INVENTION

1. Technical Field:

The present invention relates in general to an improved disk drive, and in particular to an improved actuator arm design that reduces the power consumed by data storage devices.

2. Description of the Prior Art:

Generally, a data access and storage system consists of one or more storage devices that store data on magnetic or optical storage media. For example, a magnetic storage device is known as a direct access storage device (DASD) or a hard disk drive (HDD) and includes one or more disks and a disk controller to manage local operations concerning the disks. The hard disks themselves are usually made of aluminum alloy or a mixture of glass and ceramic, and are covered with a magnetic coating. Typically, two or three disks are stacked vertically on a common spindle that is turned by a disk drive motor at several thousand revolutions per minute (rpm).

The only other moving part within a typical HDD is the actuator assembly. The actuator moves magnetic read/write heads to the desired location on the rotating disk so as to write information to or read data from that location. Within most HDDs, the magnetic read/write head is mounted on a slider. A slider generally serves to mechanically support the head and any electrical connections between the head and the rest of the disk drive system. The slider is aerodynamically shaped to glide over moving air in order to maintain a uniform distance from the surface of the rotating disk, thereby preventing the head from undesirably contacting the disk.

Typically, a slider is formed with an aerodynamic pattern of protrusions (air bearing design) on its air bearing surface (ABS) that enables the slider to fly at a constant

height close to the disk during operation of the disk drive. A slider is associated with each side of each platter and flies just over the platter's surface. Each slider is mounted on a suspension to form a head gimbal assembly (HGA). The HGA is then attached to a semi-rigid actuator arm that supports the entire head flying unit. Several semi-rigid arms may be combined to form a single movable unit having either a linear bearing or a rotary pivotal bearing system.

The head and arm assembly is linearly or pivotally moved utilizing a magnet/coil structure that is often called a voice coil motor (VCM). The stator of a VCM is mounted to a base plate or casting on which the spindle is also mounted. The base casting with its spindle, actuator VCM, and internal filtration system is then enclosed with a cover and seal assembly to ensure that no contaminants can enter and adversely affect the reliability of the slider flying over the disk. When current is fed to the motor, the VCM develops force or torque that is substantially proportional to the applied current. The arm acceleration is therefore substantially proportional to the magnitude of the current. As the read/write head approaches a desired track, a reverse polarity signal is applied to the actuator, causing the signal to act as a brake, and ideally causing the read/write head to stop directly over the desired track.

As the operating speeds of disk drives and the performance demands by users of disk drives both continue to increase, the need to make additional improvements to current drive designs persists. In particular, power consumption and heat generation by the disk drives continues to plague disk drive manufacturers. In the prior art, attempts to reduce power consumption have included, for example, shrouds around the disk stack (spindle motor and disk assembly), all of which have met with limited success. Thus, an improved disk drive design which overcomes these disadvantages while improving the performance of the disk drive would be desirable.

SUMMARY OF THE INVENTION

One embodiment of a disk drive utilizes an actuator arm design that significantly reduces air flow drag within the drive. The leading and trailing edges of the arm are aerodynamically shaped to reduce their coefficient of air flow drag in order to reduce the running current and seeking current of the disk drive during operation. As a result, the disk drive consumes less power and, thus, produces less heat which must be dissipated. The spindle motor design is reconfigured at a lower torque constant, thereby lowering the overall cost of the device.

The foregoing and other objects and advantages of the present invention will be apparent to those skilled in the art, in view of the following detailed description of the preferred embodiment of the present invention, taken in conjunction with the appended claims and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

So that the manner in which the features, advantages and objects of the invention, as well as others which will become apparent, are attained and can be understood in more detail, more particular description of the invention briefly summarized above may be had by reference to the embodiment thereof which is illustrated in the appended drawings, which drawings form a part of this specification. It is to be noted, however, that the drawings illustrate only a preferred embodiment of the invention and is therefore not to be considered limiting of its scope as the invention may admit to other equally effective embodiments.

Figure 1 is a plan view of a disk drive having an actuator arm constructed in accordance with the present invention.

Figure 2 is a front isometric view of the actuator arm of Figure 1.

Figure 3 is a side isometric view of the actuator arm of Figure 1.

Figure 4 is a top view of the actuator arm of Figure 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE PRESENT INVENTION

Referring to **Figure 1**, a schematic drawing of one embodiment of an information storage system comprising a magnetic hard disk file or drive **111** for a computer system is shown. Drive **111** has an outer housing or base **113** containing a plurality of stacked, parallel magnetic disks **115** (one shown) which are closely spaced apart. Disks **115** are rotated by a spindle motor assembly **131** having a central drive hub **117**. An actuator **121** comprises an actuator body or comb having a plurality of parallel actuator arms **125** (one shown). Actuator **121** is pivotally mounted to base **113** about a pivot assembly **123**. A controller **119** is also mounted to base **113** for selectively moving the comb of arms **125** relative to disks **115**.

In the embodiment shown, each arm **125** has extending from it at least one cantilevered load beams or suspensions **127**, a magnetic read/write transducer or head **129** mounted on a slider secured to a flexure that is flexibly mounted to each suspension **127**. The read/write heads **129** magnetically read data from and/or magnetically write data to disks **115**. The level of integration called head gimbal assembly is head **129** and the slider are mounted on suspension **127**. Suspensions **127** have a spring-like quality which biases or urges the slider against the disk to enable the creation of the air bearing film between the slider and disk surface. A voice coil **133** housed within a conventional voice coil motor magnet assembly **134** (top pole not shown) is also mounted to arms **125** opposite the head gimbal assemblies. Movement of the actuator **121** (indicated by arrow **135**) by controller **119** moves head gimbal assemblies **129** radially across tracks on the disks **115** until the heads **129** settle on the target tracks. The head gimbal assemblies operate in a conventional manner and always move in unison with one another, unless drive **111** uses multiple independent actuators (not shown) wherein the arms can move independently of one another.

Referring now to **Figures 2-4**, actuator **121** is illustrated in the preferred embodiment of the present invention. For simplicity, suspensions **127** and head gimbal assemblies **129** have been removed. In the version shown, actuator **121** is configured with a pair of parallel, substantially flat actuator arms **125**, although it may have more or fewer arms **125**. Each actuator arm **125** has a pair of narrow side edges **141, 143**. In this document, the side edges will be referred to as leading edge **141** and trailing edge **143**. In the preferred embodiment, leading edge **141** and trailing edge **143** are symmetrical and substantially identical with generally triangular cross-sectional shapes. However, leading edge **141** may be shaped, sized, and/or tailored differently from trailing edge **143**, depending upon the application for which they are intended. For example, edges **141, 143** may be rounded, tear drop-shaped, or any combination thereof.

As shown in **Figure 4**, edges **141, 143** may be tapered at their distal ends **145, 147** and/or their proximal ends **149, 151**, respectively. Ideally, each edges **141, 143** extends from pivot assembly aperture **153** (for pivot assembly **123**) all the way to the staking tongues **155** to which suspensions **127** attach. Edges **141, 143** may be shaped and extend for the entire length of arm **125**, including tongues **155**. Thus, edges **141, 143** have aerodynamic profiles that reduce a coefficient of air flow drag for actuator arm **125** as actuator **121** moves relative to disk **115**. In addition, the edges of the weight-reducing holes or apertures located in the interiors of arms **125** (essentially between edges **141, 143**) also may be shaped in a manner similar to those described above for edges **141, 143**. Having aerodynamic profiles circumscribing these holes yields an even lower coefficient of air flow drag for arms **125**.

The present invention has several advantages. A hard disk drive constructed in accordance with the present invention significantly reduces air flow drag within the drive. The aerodynamic design of the actuator arm reduces the running current and seeking current required by the disk drive during operation. As a result, the disk drive consumes less power and, thus, produces less heat which must be dissipated. In addition, the spindle motor design is modified to lower the cost of the device. The actuator arm

design of the present invention is particularly well suited for hard disk drive applications wherein the disks spin at rotational speeds of 15,000 rpm or more, and wherein sub-5 ms seek times are required.

While the invention has been shown or described in only some of its forms, it should be apparent to those skilled in the art that it is not so limited, but is susceptible to various changes without departing from the scope of the invention.